APPENDIX B

LISTING OF ALL PENDING CLAIMS

1. (Amended) A quantum computing structure comprising:

a first bank of a superconducting material having a first crystal orientation;

a mesoscopic island of a superconducting material having a second crystal orientation, wherein at least one of the island and the bank comprises a d-wave superconducting material; and

a clean Josephson junction between the island and the bank.

2. The structure of claim 1, further comprising a single electron transistor connected between the island and ground.

3. The structure of claim 1, wherein the Josephson junction comprises a grain boundary between the bank and the island.

4. The structure of claim 1, wherein the island comprises a d-wave superconducting material.

5. The structure of claim 4, wherein the bank comprises a d-wave superconducting material.

6. The structure of claim 1, further comprising:

a second bank of superconducting material having a third crystal orientation; and

a Josephson junction between the first and second banks.

7. The structure of claim 6, further comprising a single electron transistor coupled between the second bank and the island.

8. (Amended) A quantum register comprising:

a bank of a superconducting material;

a plurality of mesoscopic islands of superconducting material; and

a plurality of clean Josephson junctions, each clean Josephson junction being between the bank and a corresponding one of the islands.

9. (Amended) The quantum register of claim 8, wherein each of the mesoscopic islands comprises a d-wave superconductor.

10. The quantum register of claim 9, wherein the bank comprises a d-wave superconductor.

11. The quantum register of claim 8, further comprising a plurality of single electron transistors, each electron transistor being between ground and a corresponding one of the islands.

12. The quantum register of claim 8, further comprising a first plurality of single electron transistors, each single electron transistor in the first plurality being between islands in a corresponding pair of the islands.

13. (Amended) The quantum register of claim 12, further comprising a second plurality of single electron transistors, each single electron transistor in the second plurality being between ground and a corresponding one of the plurality of mesoscopic islands.

14. The quantum register of claim 8, further comprising:
a second bank of superconducting material; and
a Josephson junction between the first and second banks.

15. The quantum register of claim 14, further comprising a first plurality of single electron transistors, each single electron transistor being coupled between the second bank and a corresponding one of the islands.

16. The quantum register of claim 15, further comprising a second plurality of single electron transistors, each single electron transistor in the second plurality being between ground and a corresponding one of the islands.

17. The quantum register of claim 15, further comprising a second plurality of a single electron transistors, each single electron transistor in the second plurality being between islands in a corresponding pair of the islands.

18. (Amended) The quantum register of claim 17, further comprising a third plurality of single electron transistors, each single electron transistor in the third plurality being between ground and a corresponding one of the plurality of mesoscopic islands.

28. A qubit, comprising:

a first bank of a superconducting material having a first crystal orientation;

a mesoscopic island having a second crystal orientation formed adjacent to the first bank; and

a clean Josephson junction formed between the first bank and the mesoscopic island, wherein the first crystal orientation and the second crystal orientation are different.

29. The qubit of Claim 28, wherein at least one of the first bank and the mesoscopic island is formed of a d-wave superconducting material.

30. The qubit of Claim 28, further including a grounding mechanism coupled between the mesoscopic island and a ground.

31. The qubit of Claim 30, wherein the grounding mechanism is a single electron transistor.

32. The qubit of Claim 30, wherein the grounding mechanism is a parity key.

33. The qubit of Claim 28, wherein the clean Josephson junction includes a grain boundary between the island and the first bank.

34. The qubit of Claim 28, wherein the clean Josephson junction includes a normal metal.

35. The qubit of Claim 28, further comprising:

a second bank of superconducting material having a third crystal orientation; and

a Josephson junction formed between the first bank and the second bank.

36. The qubit of Claim 35, further comprising:

a coupling mechanism coupled between the mesoscopic island and the second bank.

37. The qubit of Claim 36, wherein the coupling mechanism includes a single electron transistor.

38. The qubit of Claim 36, wherein the coupling mechanism includes a parity key.

39. (Amended) A quantum register, comprising:

a first bank of superconducting material;

at least one mesoscopic island of a superconducting material; and

at least one Josephson junction, each Josephson junction in said at least one Josephson junction formed between a mesoscopic island in the at least one mesoscopic island and the first bank.

40. The quantum register of Claim 39, wherein the bank includes a d-wave superconductor.

41. The quantum register of Claim 39, wherein at least one of the mesoscopic islands includes a d-wave superconductor.

42. The quantum register of Claim 39, further including at least one first coupling mechanism, each of the at least one first coupling mechanisms coupling a corresponding one of the at least one mesoscopic islands to ground.

43. The quantum register of Claim 42, wherein at least one of the first coupling mechanisms includes a single electron transistor.

44. The quantum register of Claim 42, wherein at least one of the first coupling mechanisms includes a parity key.

45. The quantum register of Claim 39, wherein at least one pair of mesoscopic islands are coupled by a second coupling mechanism.

46. The quantum register of Claim 45, wherein the second coupling mechanism includes a single electron transistor.

47. The quantum register of Claim 45, wherein the second coupling mechanism includes a parity key.

48. The quantum register of Claim 39, further including:
a second bank of superconducting material; and
a Josephson junction formed between the second bank and the first bank.

49. The quantum register of Claim 48, further including at least one third coupling mechanism coupled between one of the mesoscopic islands and the second bank.

50. The quantum register of Claim 49, wherein the third coupling mechanism includes a single electron transistor.

51. The quantum register of Claim 49, wherein the third coupling mechanism includes a parity key.

52. (Amended) The structure of claim 1, wherein a qubit is formed by the first bank, the mesoscopic island and the clean Josephson junction, and wherein each quantum state on the qubit is characterized by a clockwise or a counterclockwise supercurrent that circulates in a plane in the vicinity of the clean Josephson junction.

53. (Amended) The quantum register of claim 8, wherein a plurality of qubits is formed by the plurality of mesoscopic islands, the bank, and the plurality of clean

Josephson junctions, and wherein each quantum state on each respective qubit in said plurality of qubits is characterized by a clockwise or a counterclockwise supercurrent that circulates in a plane in the vicinity of the Josephson junction in said respective qubit.

54. (Amended) The qubit of claim 28, wherein each quantum state on the qubit is characterized by a clockwise or a counterclockwise supercurrent that circulates in a plane in the vicinity of the clean Josephson junction.

55. (Amended) The quantum register of claim 39, wherein a qubit is formed by each mesoscopic island in the at least one mesoscopic island together with the first bank and a Josephson junction in the at least one Josephson junction, and wherein each quantum state of each said qubit is characterized by a clockwise or a counterclockwise supercurrent that circulates in a plane in the vicinity of the Josephson junction in said qubit.

56. The structure of claim 1, wherein a qubit is formed by the first bank, the mesoscopic island and the clean Josephson junction, and wherein the qubit has a quantum state that is twice degenerate in the absence of an external electromagnetic field.

57. The quantum register of claim 8, wherein a plurality of qubits is formed by the plurality of mesoscopic islands, the bank, and the plurality of clean Josephson junctions, and wherein each qubit in said plurality of qubits has a quantum state that is twice degenerate in the absence of an external electromagnetic field.

58. The qubit of claim 28, wherein the qubit has a quantum state that is twice degenerate in the absence of an external electromagnetic field.

59. The quantum register of claim 39, wherein a qubit is formed by each mesoscopic island in the at least one mesoscopic island together with the first bank and a Josephson junction in the at least one Josephson junction, and wherein each said qubit has a quantum state that is twice degenerate in the absence of an external electromagnetic field.

60. A qubit comprising:

a first bank of a superconducting material having a first crystal orientation;

a mesoscopic island of a superconducting material having a second crystal orientation, wherein at least one of the islands and the bank comprises a d-wave superconducting material;

a clean Josephson junction between the island and the bank, wherein the Josephson junction is configured so that a supercurrent proximate to the Josephson junction alternates between a first ground state having a first magnetic moment and a second ground state having a second magnetic moment by means of quantum tunneling; and

circuitry to allow selective interruption of quantum tunneling between the first ground state and the second ground state.

61. The qubit of claim 60, wherein the circuitry comprises a parity key that connects the island to ground.

62. The qubit of claim 60, wherein the circuitry comprises a single electron transistor that connects the island to ground.

63. A quantum computer comprising the qubit of claim 60 and a readout device for detecting whether the supercurrent has the first magnetic moment or the second magnetic moment.

64. A quantum register comprising:

a bank of a superconducting material;

a plurality of mescopic islands of superconducting material;

a plurality of clean Josephson junctions, wherein each Josephson junction:

is between the bank and a corresponding one of the islands ; and

is configured so that a supercurrent proximate to each Josephson junction alternates between a first ground state having a first magnetic moment and a second ground state having a second magnetic moment by means of quantum tunneling; and

circuitry to allow selective interruption of quantum tunneling between the first ground state and the second ground state of the supercurrent associated with each Josephson junction.

65. A quantum computer comprising the quantum register of claim 64 and a readout device for detecting whether the supercurrent of each Josephson junction has the first magnetic moment or the second magnetic moment.